PRINCETON UNIVERSITY OBSERVATORY

Princeton, New Jersey

Semiannual Progress Report No. 6*
1 October 1965 - 31 March 1966

National Aeronautics and Space Administration Grant NsG-414

Purpose: Experimental and theoretical studies of ultraviolet phenomena of importance in space astronomy.

Personnel: Principal investigators: Dr. Lyman Spitzer, Jr., and Dr. Kurt Dressler.
Full time research staff: Dr. George M. Lawrence.
Part time: J. E. Hesser, D. L. Mickey, B. D. Savage, and M. Dobrowolny, graduate students; two specialists and two technicians.

Activities: 1. Atomic transition probabilities.

Measurements of radiative lifetimes have been made for some 50 atomic multiplets including the strongest transitions of the neutral and singly ionized elements B, C, N, O, Si, P, S, Cl, Ge, Se, Br, and Sn. Results on B, C, and N have been published by Lawrence and Savage, and results on Si, P, and S are being prepared for publication by Savage.

Lawrence has made calculations of relative transition probabilities for approximately 400 ultraviolet transitions of neutral Si, P, S, Cl, Ge, As, Se, Br, Sn, Sb, I, and Pb, using intermediate coupling theory. Absolute scale for these calculations is provided by our laboratory lifetime measurements. For the same elements, Lawrence has evaluated numerical solutions of the radial Schroedinger equation for the p^n and p^{n-1} s configurations, enabling extrapolation of the Bates-Damgaard tables for use with resonance transitions of the non-metals. Accuracy of the calculation seems to be ±30% for the above elements. Papers describing these two sets of calculations are in preparation.

2. Molecular transition probabilities.

Hesser has measured radiative lifetimes in N_2 (B and C states), N_2 (C and p'), N_2^+ (B), CO (A, B and C), CO^+ (B), CO_2^+ (2 states), NO (A, C, D, B' and F), NO^+ ($\tilde{A}$), BF (A), BF_2, CF (B), CF_2, CCl, and SiF (B). A careful study of the influence of various plausible sources of systematic errors was conducted, with special attention on radiative cascading and pressure effects. A preliminary earlier result for the NO D-state had to be changed, while our previously published lifetimes for the A-state of CO are confirmed. The lifetime of the v=2 level of the A state is found to be 10.8 or 11.5 nanosec depending on whether some cascading from a shorter-lived higher lying state is assumed to be present or absent. The corresponding f-value for the A-X 2-0 band is 0.021-0.020. Thus the discrepancy with the value f(2-0) = 0.051 derived by Lassettre et al, from inelastic electron scattering cross-sections is not removed.

It is planned to set up equipment for measurement of relative emission intensities for the determination of electronic and vibrational branching ratios. These data are needed to interpret the lifetime data unambiguously in terms of precise absorption oscillator strengths.

N66-82775
(ACCESSION NUMBER)
2
(PAGES)
CR 71802
FACILITY FORM 602
(THRU)
none
(CODE)

The strongest absorption bands of N_2 have been recorded by Mickey in the 950-980 A region to evaluate absolute absorption oscillator strengths. The 3-meter spectrograph was used with helium-continuum light source, differential pumping system, and double-beam photoelectric recording using pulse-counting electronics. The spectrograph chamber served as the absorption cell, with N_2 gas pressures accurately monitored in the 10^{-4} to 10^{-5} mm Hg range. A resolution of 0.042 A was employed, which is twelve times higher than previously reported in photoelectric absorption work in this spectral region. This enabled recording of absorption coefficients at pressure x pathlength products down to more than ten times lower than previously reported. Thus the effects of line saturation were substantially reduced, and an apparent discrepancy between the low-resolution absorption coefficients of Huffman, Tanaka and Larrabee and electron scattering cross sections has been resolved.

Publications: The following scientific papers have been published during the reporting period:

1. "Absolute Transition Probabilities of the Solar Ultraviolet CO Bands," by J. E. Hesser and K. Dressler, Astronomical Journal, Vol. 70, 677 (Nov. 1965).

2. "Radiative Lifetimes of UV Multiplets in Boron, Carbon, and Nitrogen," by G. M. Lawrence and B. D. Savage, Physical Review, Vol. 141, 67 (Jan. 1966).

3. "Hydrogen Molecules in Astronomy," by G. B. Field, W. B. Somerville, and K. Dressler, accepted for publication in Annual Reviews of Astronomy and Astrophysics, Vol. 5 (1966), L. Goldberg, Ed. (Annual Reviews, Inc., Palo Alto, Calif.).

4. "Lifetimes with the Phase Method," by G. M. Lawrence, Bulletin of the American Physical Society, Vol. 11, 61 (Jan. 1966), paper presented at the Annual Meeting of the American Physical Society, New York, January 1966.

5. "Absolute Transition Probabilities of Ultraviolet Molecular Transitions," by J. E. Hesser, paper presented at the Meeting of the American Astronomical Society, N.A.S.A. Langley Research Center, Hampton, Va., March 1966.

*This report is intended for the internal use of the contractor and NASA.

4/7/66